Automatic Power Foldback for Audio Applications

PRIORITY CLAIM

[0001] This application claims priority of US Provisional Patent, Serial No. 60/479,355, filed June 17, 2003, entitled "Automatic Power Foldback (APF) for USB Audio Applications", the teaching of which are incorporated herein by reference.

TECHNICAL FIELD OF THE INVENTION

[0002] This invention relates to controlling power in an audio application, and more particularly to automatically controlling the power of an audio amplifier by using the volume inputs to a pre-amp source which drives the audio amplifier.

BACKGROUND OF THE INVENTION

[0003] In some audio applications it is sometimes necessary to limit the amount of power used by an audio amplifier due to power constraints. In a particular application, an audio amplifier that drives the speakers for a computer sound system has a limited amount of power available to the amplifier. In this system, an audio power amplifier is powered directly from a personal computer's USB (Universal Serial Bus) port. This is desirable to reduce the audio speakers wiring to a single connection to the speakers from the USB port. The USB interface connection includes power as well as a data bus. Power limitations of the USB port are defined by an accepted bus interface standard. The power is typically limited to 1/2 amp at 5 volts.

[0004] Overdriving the audio without limiting the current drawn on the USB port could damage the PC's USB drive circuits or cause them to current limit and shut down. Some prior art circuits would cut the current to the audio amplifier if the current draw rose to high. This would case an undesirable pause or stop in the audio output.

SUMMARY OF THE INVENTION

[0005] The present invention overcomes problems associated with the described prior art. In a preferred embodiment, the audio volume level of an DAC is controlled with a simple circuit to prevent an audio amplifier from drawing more than a specified amount of power.

[0006] Preferred embodiments of the present invention are directed to a USB speaker audio driver circuit. In this circuit a stereo audio digital to analog converter (DAC) with a USB interface receives a digitally encoded audio signal from a personal computer (PC). The USB DAC outputs an analog audio signal to a audio amplifier circuit. A supervisory circuit monitors the power used by the audio amplifier and through a volume control circuit lowers the volume control into the USB DAC to prevent the entire circuit from drawing more than the allowed power supplied by the USB connection to the PC.

[0007] Advantages of an embodiment of the present invention include a smooth reduction in volume without manual control when power limiting occurs. The circuit can adjust whenever needed to prevent power limiting without cutting out or losing contact with the data bus that was prevalent in prior art designs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIGURE 1 illustrates a block diagram of an automatic power foldback circuit according to an embodiment of the present invention.

FIGURE 2 illustrates a circuit diagram of an automatic power foldback circuit according to an embodiment of the present invention.

FIGURE 3 illustrates a detailed circuit diagram of a USB speaker drive circuit which includes an automatic power foldback circuit according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] FIGURE 1 illustrates a block diagram of an audio amplifier circuit **10** with automatic power foldback according to an embodiment of the present invention. A pre-amplifier circuit **12** (which may include a DAC) receives a data **14** and a power **16** signal. The pre-amplifier circuit outputs an enable signal **18** and a pre-amplified analog audio signal **20** to an amplifier **22**. The amplifier **22** outputs audio signals **24, 26** for headphones and speakers (not shown).

[0010] Power for the circuits is provided by the power bus **16**. Optionally, power can be supplied by a DC power input circuit **28**. In this case, a load control circuit **29** is connected to the DC power input **30**, and a supply selection **32** is made if there is power available from the DC input. (However, in the preferred embodiments described in more detail below, the advantage of the present invention is primarily achieved when the DC power input is not used and power is supplied by the USB power bus.) A supervisory power circuit **34** monitors the power used by the entire circuit, or that supplied to the audio amplifier. The supervisory power circuit **34**

signals the volume control circuit **36** when power sags or exceeds the specified limit. The supervisor circuit may monitor the voltage level or current used.

[0011] The volume control circuit **36** inputs from the power supervisor circuit an indication of an over power limit state. The volume control circuit then outputs to the pre-amplifier circuit a signal that connects to the volume control of the pre-amplifier **12**. The volume control circuit then adjusts the volume lower until indicated by the supervisory circuit **34**.

[0012] FIGURE 2 illustrates a circuit diagram of an audio amplifier circuit **100** with automatic power foldback according to another embodiment of the present invention. This circuit provides a computer speaker drive system that allows the PC to drive audio speakers with just a USB connection from the PC to the speakers. Power for the speaker audio amplifier is also supplied by the USB port connection. The system includes a decoder to decode the digital audio signal to an analog audio pre-amplified signal, and an audio amplifier to drive the speakers. A USB DAC **112** includes a pre-amplifier circuit. The USB DAC **112** receives a data **114** and power **116** signal from a computer (not shown). The data signal **114** is a digital data stream containing an audio signal. The USB DAC has a USB interface to receive the digital data stream from the computer (not shown) and a decoder to convert the audio signal back to an analog signal. In the illustrated embodiment, the USB DAC is a Burr-Brown Product PCM 2900 from Texas Instruments Incorporated.

[0013] The USB DAC outputs an enable signal **118** and a pre-amplified analog audio signal **120** to an amplifier **122**. The amplifier **122** outputs audio signals for headphones and speakers (not shown). In the illustrated embodiment, the audio amplifier is a TPA2000D4 from Texas Instruments Incorporated.

[0014] Power for the circuits is provided by the power bus **116**. A supervisory power circuit **134** monitors the power used by the circuit including the audio

amplifier. The supervisory power circuit **134** signals the volume control circuit **136** when power sags or exceeds the specified limit. In this embodiment, the supervisor circuit monitors the voltage level. In this embodiment, the supervisor power circuit is a TPS3825 part supplied by Texas Instruments Inc.

[0015] The volume control circuit **140** inputs from the power supervisor circuit an indication of an over power limit state. The volume control circuit then adjusts the volume lower until indicated by the supervisory circuit **134**. When the voltage monitored by the supervisory circuit falls below 4.55 v, the reset(bar) output is asserted low. The reset(bar) output is connected to the gate of transistor **138**. When activated, transistor **138** connects the volume control input - down **140** which lowers the audio signal output from the USB DAC. The volume control circuit also has switches **142** connected to each of the volume control inputs of the USB DAC to allow the user to manually adjust the volume of the speakers.

[0016] In an embodiment of the present invention, a resistor **144** is added between the USB power input and the Vcc source supplied to the audio amplifier and may also include the USB DAC chip. This resistor **144** is chosen to set the current trip point of the supervisory circuit **134**. The resistor can be chosen to produce a trip point voltage (in this case 4.55 v) when the limit current is reached. This can be done to insure the entire circuit does not draw more than the USB standard dictates. On the other hand, the resistor can be left out of the circuit, and the current draw limited by the ability of the USB source. In this case the volume to the speakers could be potentially greater, but the circuit would depend on the USB source to protect against an overcurrent condition on the USB source.

[0017] FIGURE 3 illustrates a circuit diagram of an audio amplifier circuit **100** with automatic power foldback according to another embodiment of the present invention. This embodiment is essentially the embodiment described above with reference to Figure 2 and includes the optional DC power input described in the

discussion of Figure 1. This schematic includes circuit features that are not essential to the invention claimed herein, but the schematic shows a complete implementation of the claimed circuit used in a computer speaker audio system which is driven from a USB.

Other Embodiments

[0018] Although the present invention has been described in detail, it should be understood that various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.